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RADIATION AND MATTER[1]

WE must congratulate ourselves upon the fact that we have been able to listen to such clear, concise and accurate presentations of the most fundamental problems that lie before pure science to-day. I would like, also, to extend to the speakers our sincere thanks for their efforts in giving us such interesting expositions of these abstruse theories.

It is my privilege to open the discussion on radiation and the structure of matter. Modern theories of radiation are largely concerned with Planck's conception of the radiation of energy in quanta, and with the extraordinary action constant usually denoted by the letter "*h*." I would like to present for your discussion some ideas on the relations between the high frequency vibrations which we observe in general *X*-radiation, and the forces holding the electrons and atoms together, including a physical conception of what this constant "*h*" really means.

Instead of basing the discussion on the conceptions of entropy, and thermo-dynamic probability, I shall start from our recent experiments on general *X*-radiation.

Before we learned from experiments that *X*-rays had definite wave-lengths, people supposed that they had, and that we could calculate their frequencies by the formula kinetic energy equals $h\nu$.

$$(1) \qquad \tfrac{1}{2} m v^2 = h\nu.$$

[1] Presented at the symposium on "The Structure of Matter" at a joint meeting of the Sections of Physics and Chemistry of the American Association for the Advancement of Science, The American Physical Society and the American Chemical Society, New York, December 27, 1916.

We have shown, by experiments at Harvard, that this equation is not, in general, true, but that it does hold for particular cases. Mr. Hunt and I investigated the general X-radiation from a Coolidge tube, excited by a high potential constant voltage storage battery, using an X-ray spectrometer, and found that although the effective, or average, frequency does not obey the law represented in the equation (1), the equation does give the maximum frequency obtainable with a given electron energy. Dr. Webster then examined the characteristic X-radiation, and discovered that the kinetic energy of the electrons required to produce the alpha and beta lines of the K series is larger than is represented by equation (1), but that the gamma line (the highest frequency line in this series) approximately obeys the law. It appears, therefore, from our experiments, that equation (1) gives the maximum frequency of the radiation due to an electron's hitting an atom, but does not, in general, mean that the entire amount of the electron's energy is radiated at frequency ν.

I have recently shown that it is not necessary to assume that energy is radiated in quanta "h" in order to deduce equations for the distribution of energy in emission spectra similar to the equations representing black body radiation, so that we are not compelled to believe that because Planck's radiation law fits the facts of black body radiation more or less closely, therefore energy must be radiated in quanta $h\nu$. In attempting to explain why this constant "h" enters into the radiation law and in seeking for a physical conception of the mechanism of radiation, we are not therefore compelled to explain the emission of radiation in quanta $h\nu$, but rather the fact that an electron with a given kinetic energy, when it hits an atom, can produce radiations of frequency up to but not greater than that given by equation (1). This is the fundamental fact that needs explanation.

According to the modern conception of the constitution of matter, an atom possesses a complicated electro-magnetic structure in which the electrons play an important rôle. The electro-magnetic forces in this structure are greater near its center than at the periphery, and therefore the high frequency vibrations of the electrons must be associated with parts of the atom near its center. Hence, the reason why an electron can not produce a high frequency radiation unless it possesses a certain kinetic energy lies in the fact that it does not penetrate far into the atom unless it has a sufficient speed. This presupposes a force of repulsion between the electron and the atom. The theory of atomic structure seems to demand such a force in order to explain why atoms do not collapse; so that we have confirmation of the existence of such forces from two sides: the radiation and the structure of matter.

Before discussing further the nature of this force and the laws it must obey, I would like to present to you a conception of the difference between line spectra and the general, or continuous spectra. The frequencies of the characteristic lines depend upon the nature of the atoms struck by the electrons, whereas the frequencies of the general radiation depend upon the kinetic energy of the electron that does the striking. This suggests that the characteristic lines are due to vibrations of parts of the atoms themselves (of electrons in the atoms, for instance) whereas the general radiation or continuous spectrum is due to the vibrations of the electrons that hit the atoms.

The question now arises "How can an electron vibrate with all possible frequency so as to give a continuous spectrum?" The electron moves in the strong electromagnetic field of the atom, and when an

electron moves in a strong magnetic field, it follows a spiral path around a line of force. This motion in a spiral path radiates energy with a frequency that depends on the strength of the field, and is therefore variable. It is easily shown that in a case where the spiral is tightly wound around a line of magnetic force, the frequency is given by the equation

$$\nu = \frac{H}{2\pi}\frac{e}{m}. \qquad (2)$$

From this equation it appears that the frequency is independent of the velocity of the electron and of the radius of the spiral and that it is practically proportional to the strength of the magnetic field; and since H varies continuously, the frequency can have all possible values (up to a maximum), which gives the radiation the character of a continuous spectrum.

Let us combine this conception of general X-radiation with the experimental fact that the maximum frequency due to the impact of an electron against an atom is given by equation (1). Suppose the electron to be traveling very nearly along the line of force coming from a very great distance, where its velocity is v and let x be its distance from any fixed point at the time t; let F be the total force acting on the electron in the direction of the weaker magnetic field. Then we can show easily that

$$F = \frac{h}{2\pi}\cdot\frac{e}{m}\cdot\frac{\partial H}{\partial x}. \qquad (3)$$

We find, therefore, that a force of repulsion acting on the electron, the magnitude of which is represented by equation (3), will explain why an electron of given kinetic energy can not produce radiation higher than that given by equation (1).

A force such as that represented by equation (3) should hold an electron in equilibrium at a distance somewhat smaller than 10^{-8} from an atomic nucleus, if the nucleus had a charge e and the magnetic moment attributed to atoms and magnetons. Such a force would play an important rôle in determining the size and compressibility of atoms, the conduction of heat and specific heats, and a great variety of phenomena.

WILLIAM DUANE
HARVARD UNIVERSITY

THE RELATIONS OF MAGNETISM TO MOLECULAR STRUCTURE

MAXWELL'S classical theory of electricity and magnetism contributes little to our knowledge of molecular structure. For the portion of it which deals with material substances is exhibited in terms of quantities for which the process of definition wipes out structural distinctions. It is only through molecular theories of magnetism that magnetic phenomena may be correlated with molecular structure.

Langevin's theory of magnetism appears to be the soundest attempt to formulate such a theory. He hypothecates the existence in the molecules of every substance of groups of electronic orbits which by virtue of the peculiarities of the structure of the molecules may be so arranged that the resultant magnetic field due to the electronic orbits in a given molecule at points without the molecule may or may not vanish. In the former case the molecule is diamagnetic, in the latter magnetic.

The effect of the application of a magnetic field to a diamagnetic substance is to change the orbital velocity of any electron. This change is in the proper direction to account for the diamagnetic polarity of the substance. Langevin's theory leads to an expression for diamagnetic susceptibility which does not involve the temperature, in agreement with Curie's law for diamagnetism. Numerous exceptions to this law exist, but the exceptions may probably all be taken care of by a slight extension of Langevin's theory as proposed by Oxley.

One of Oxley's most interesting conclusions is that the mutual magnetic field of two diamagnetic molecules in intimate contact is of the order of 10^7 gausses.

Langevin's hypothesis, while probably the most satisfactory yet advanced, leaves us quite in the dark as to a mechanical explanation of the architecture of the molecule.

In paramagnetic and ferromagnetic substances in accordance with the views of Langevin the rôle played by the molecule is not as in diamagnetic substances independent of the molecule's orientation in space, and it is necessary to assume that the effect of an applied field is to rotate the electronic orbits so that the direction of the resultant external field of a molecule tends toward that of the applied field. But the theory tells us nothing of the mechanism which will account for this orientation. Resisting the orientation will be heat agitation and perhaps inter-atomic and molecular actions of other than magnetic type. In a paramagnetic gas the resistance to orientation is supposed to be entirely due to heat agitation. The theory for such a gas leads to an expression for the susceptibility which depends upon both the impressed field and the temperature, but for fields attainable in the laboratory the susceptibility varies inversely with the absolute temperature in accordance with Curie's law for paramagnetism.

With the aid of the assumption that as regards rotation the molecules of a paramagnetic liquid behave like those of a paramagnetic gas it is possible to extend the theory of the gas to include that of the liquid, and such an extension is probably reasonably safe for liquids not given to polymerization.

In Weiss's theory of ferromagnetism it is assumed that, so far as rotation is concerned, the molecules of a ferromagnetic substance behave like those of a paramagnetic gas, a somewhat questionable assumption in this case. The effect of neighboring molecules upon a given molecule is assumed to be that which would be produced by a very large localized magnetic field of the order of 10^7 gausses. The theory based on these assumptions succeeds to a remarkable extent in explaining many of the facts of ferromagnetism.

The large internal fields hypothecated by Weiss and by Oxley are to be regarded as devices for averaging out in a measure the complicated effects due to molecular structure.

Through experiment Weiss was led to belief in the existence of an elementary unit of magnetic moment which he called the magneton. This corresponds in electrical theory to the electron. In many instances the magnetic moment per molecule appears to be very nearly an integer number of magnetons. But the evidence is not weighty enough to justify the acceptance unreservedly of this proposed new physical unit.

The subject of magneto-chemistry is already a very extended one. Here the attempt is made to establish a connection between the magnetic moment of a compound and those of its constituents, and additive relations are sometimes found. Substantial chemical information is often found through magnetic analysis. Various attempts have been made to explain chemical valency bonds through the magnetic attractions of rotating electrons in the atoms. One of these, that of Parsons, offers promise of considerable success in this direction.

The recent magnetic experiments of Barnett and of Einstein and deHass appear to prove definitely the existence of electrons rotating in closed orbits within the molecules of material substances, and thus furnish important support to Langevin's fundamental assumptions.

From this necessarily inadequate discus-

sion you will infer that our molecular theories of magnetism are yet in a very unsatisfactory state in spite of the light which Langevin's ideas have thrown upon the subject, and that experiments upon the magnetic properties of bodies have not yet contributed in a very striking manner to our knowledge of molecular structure.

A. P. WILLS

COLUMBIA UNIVERSITY

ENROLLMENT IN SCIENCE IN THE HIGH SCHOOLS

IN the issue of SCIENCE for February 12, 1915 (Vol. XLI., pp. 232–235), I called attention to the significance of the data given by the Commissioner of Education in regard to the enrollment in science studies in the high schools of the United States. The appearance of additional statistics for the five-year period 1910–1914 in the 1916 Report makes it possible to review the situation in the light of the new figures.

The table on page 489 of the Report of the Commissioner of Education for 1916, Vol. II., gives a summary of the enrollment in various subjects of the high-school curriculum in 1910 and 1915, both in terms of the numbers enrolled and in the percentage of the total enrollment. It is rather startling to find that in this five-year period there has been a drop of 44 per cent. in the enrollment in botany, stated in terms of the per cent. of the total enrollment, and one of 51.3 per cent. in zoology. The decline in botany has been from 16.34 per cent. to 7.19 per cent. and in zoology from 7.88 per cent. to 4.04 per cent. Physics has nearly held its own, changing from 14.79 per cent. to 14.28 per cent. while chemistry has made a slight gain, from 7.13 per cent. to 7.63 per cent. The other old-line sciences have all dropped off, physiology and physical geography quite heavily. Nor is the gain in the newer sciences enough to counterbalance the loss in the old. The percentage enrollment in agriculture has increased from 4.55 per cent. to 6.92 per cent., in domestic science from 4.14 per cent. to 12.69 per cent. The total percentage enrolled in science in 1909–1910 was 91.99 per cent., in 1914–1915 86.16 per cent., a drop of 5.83 per cent.

It seems strange that in an age when applied science is increasingly evident on every hand in the commonplace appliances of home, farm, factory and office that there should be any decline in the relative interest in science

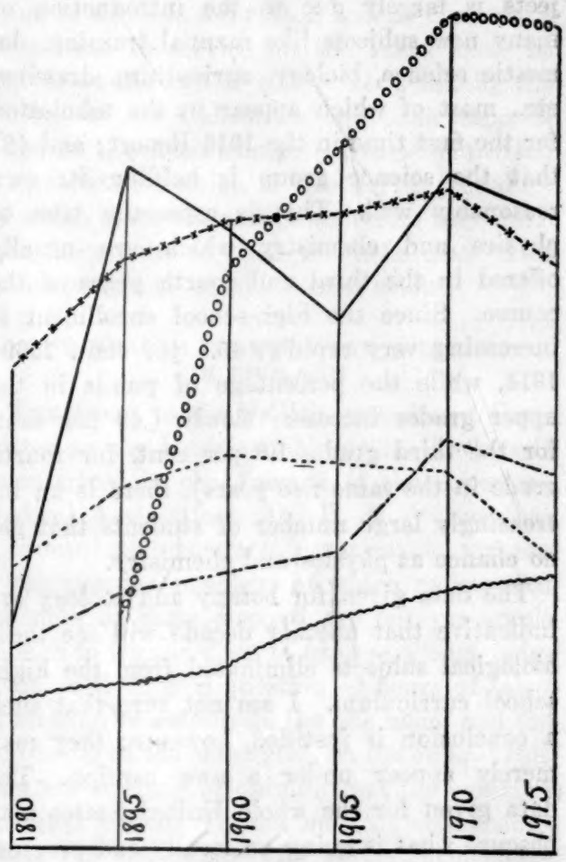

FIG. 1. Showing percentage of total enrollment in the high schools of the United States pursuing certain groups of studies, as follows: Classics, - - - - -; English, oooooo; History —.—..—..; Mathematics, -x-x-x-; Modern Language ~~~~~~; Science, ————. 1 mm. =1.2 per cent.

in the high schools. It is fairly evident that the high-school science course is in some way out of joint with the times. This decline in the science enrollment is not so alarming, however, when compared with changes in the other groups of subjects. The modern language group is the only one of the traditional subjects that shows an increase, that a small one of 1.5 per cent. The classics drop 11.04

per cent., mathematics 10.37 per cent., history 4.23 per cent., English 1.96 per cent. These changes are graphically presented in Fig. 1 and at the same time compared with the changes of the two preceding decades.

In general the interpretation put upon the data in the previous article seems still to maintain, namely (1) that the decline in the percentage of students in the old-line subjects is largely due to the introduction of many new subjects like manual training, domestic science, biology, agriculture, drawing, etc., most of which appear in the tabulation for the first time in the 1916 Report; and (2) that the science group is holding its own reasonably well. This is especially true of physics and chemistry which are usually offered in the third and fourth years of the course. Since the high-school enrollment is increasing very rapidly, 45.1 per cent. 1909–1914, while the percentage of pupils in the upper grades increases slowly (.49 per cent. for the third grade, 1.8 per cent. for fourth grade in the same five years), there is an increasingly large number of students that get no chance at physics and chemistry.

The data given for botany and zoology are indicative that another decade will see these biological subjects eliminated from the high-school curriculum. I am not sure that such a conclusion is justified, however; they may merely appear under a new caption. The data given for the whole United States may obscure what is going on locally and progress is usually local at first. Changes of opposite character may quite effectually obliterate each other when the data are massed. Thus the interest in French is largely concentrated in the New England States. More than 43 per cent. of the high-school pupils of Maine and New Hampshire are enrolled in French. The average for the New England States is 37.7 per cent.; for the North Central States, 3.07 per cent. The percentage enrollment in French has declined, though the enrollment in the modern languages has increased, largely due to the increase in Spanish in the Western States, the percentage of enrollment in it being 10.45 per cent. there, as compared with 0.76 per cent. in the North Central States.

The largest decline in botany and zoology has been in the North Atlantic States, where the percentage of enrollment has dropped in the five-year period from 16.28 per cent. to 6.46 per cent. in the former subject and in the latter from 9.64 per cent. to 3.18 per cent. But simultaneously the enrollment in biology has risen from 2.35 per cent. to 14.38 per cent. The percentage of enrollment in botany has changed in the North Central States from 17.72 per cent. to 12.79 per cent. and in zoology from 5.57 per cent. to 3.49 per cent.; but at the same time the enrollment in biology has risen from 0.13 per cent. to 1.64 per cent. and in agriculture from 4.97 per cent. to 9.78 per cent.

Botany and zoology are apparently giving way to related subjects that either appeal to school authorities as more effective educationally or to the public as more closely allied to everyday affairs. In view of the fact, now generally recognized, that knowledge and principles gained in one field of study do not carry over even into an adjacent field readily, it must be considered good policy in science instruction to deal with subject matter that is as nearly identical as possible with that which pupils will handle in their major life interests.

Elliot R. Downing

The University of Chicago,
The School of Education

SCIENTIFIC EVENTS

PROFESSOR ROBERTSON'S GIFT TO THE UNIVERSITY OF CALIFORNIA

Dr. T. Brailsford Robertson, professor of biochemistry and pharmacology in the University of California, has executed a deed donating to the University of California all his patent rights in the growth-controlling substance, "Tethelin," which he has succeeded in isolating from the anterior lobe of the pituitary body, and which has been employed to accelerate repair in slowly healing wounds. All profits resulting from this discovery are to constitute an endowment, the income to be applied to medical research.

Tests of this new chemical substance made in army hospitals in Europe and in civil hospitals in America have shown that it is of value in curing wounds and in causing wounds to heal promptly which for months or even years had refused to yield to treatment. While several new substances and new methods found by medical investigators since the war began have proved extremely useful in combating infections in wounds, "Tethelin" has a field of usefulness all its own—after other methods have rendered the tissues aseptic and wounds sometimes refuse to heal, especially where frostbite, burns, or varicose veins have injured the vitality of the tissues. There are thousands of such cases in Europe to-day and they occupy the hospitals for an exceptionally long time, consuming drugs, time, space, and food, and frequently such cases have to be discharged unhealed. It is precisely these cases—the most expensive and most disabling type of wounds—which "Tethelin" aids, since it stimulates the sluggish tissues and enables nature to work its own repair.

Professor Robertson has relinquished all personal profit from his discovery of this growth-promoting substance. In the agreement by which the regents of the University of California have accepted the trusteeship of this endowment for medical research it is provided that in case Professor Robertson should become physically disabled his present university salary would be continued throughout his lifetime, from the proceeds of the trust, or in case of his death, to his wife for her life time. All income above this contingent charge will go to endow an institute of medical research, devoted to research in medicine, and especially to research in the physiology, chemistry and pathology of growth.

Under the supervisory control of the regents of the university, the researches thus provided for are to be directed by a board of directors, of which the charter members are to be five members of the faculty of the University of California: Dr. F. P. Gay, professor of pathology; Dr. Herbert M. Evans, professor of anatomy; Dr. George H. Whipple, professor of research medicine and director of the George Williams Hooper Foundation for Medical Research; Dr. C. L. A. Schmitt, research assistant in pathology; and Professor Robertson himself. Vacancies on this board must be filled from men engaged directly and primarily in research work of the character mentioned or of some kindred character. No man who ceases to be so engaged may continue to serve as a director, and no director is to contine in service on the board after he arrives at the age of sixty. It is felt by the University of California that one especial value of the establishment of this foundation is the pattern which it sets for a procedure by which other scientific discoverers may dedicate the results of their scientific discoveries to the benefit of mankind as a whole.

THE HEALTH OF MUNITION WORKERS IN ENGLAND

THE report to the British government Committee on the Health of Munition Workers is summarized in the *Journal* of the American Medical Association. Dr. H. M. Vernon has conducted an elaborate investigation for the committee, the members of which realize that the data at their disposal are not yet ample enough to permit them to express a final judgment on the whole question of hours of labor in relation to output, on the one hand, and the well-being of the employees, on the other. But they are strongly of opinion that the evidence collected by Dr. Vernon and his conclusions merit the immediate and earnest consideration of all concerned in industrial organization at the present time. (*a*) Observations extending over a period of thirteen and one half months on the output of workers employed in making fuses showed that a reduction of working hours was associated with an increase of production both relative and absolute. The rate of production changed gradually, and did not reach an equilibrium value before the expiration of four months. Thereafter it remained steady during the period of from three and one half to five months during which it was observed. The gradual change negatives the suggestion that the effect was a mere con-

sequence of the desire to earn the same weekly wage as before the hours were shortened. (*b*) Owing to the reduction of the working time first by a change from a twelve-hour day to a ten-hour day, and subsequently by the abolition of Sunday labor, it was possible to compare output under three conditions. The group of women (numbering from eighty to one hundred) engaged in the moderately heavy labor of turning aluminum fuse bodies provided the following comparative results: (1) When actually working 66 hours a week and nominally 74.8 hours, their relative hourly production was 100 and their relative gross production 100. (2) When actually working 54.8 hours and nominally working from 58.5 to 66 hours, their hourly production was 134 and their gross production 111. (3) When actually working 45.6 hours and nominally working from 49.5 to 58.5 hours, their hourly production was 158 and their gross production 109. It is to be inferred, therefore, that had these women been working, uniformly, a nominal 50-hour week their gross output would have been as large as when they were working a nominal 66-hour week, and considerably greater than when they were working a 77-hour week. (*c*) A group of forty women engaged in the light labor of milling a screw thread on the fuse bodies improved their gross output by 2 per cent. when actually working 54.8 hours a week, the standard being their gross output when working 64.9 hours per week. A further reduction of actual working hours to 48.1 resulted in such an improvement of hourly output that the gross output was 1 per cent. less than when the actual working time was 16.8 hours more. (*d*) A group of fifty-six men engaged in the heavy labor of sizing the fuse bodies improved their hourly output by 37 per cent. and their gross output by 21 per cent. when actually working 51.2 hours, the standards being the hourly and gross outputs observed when the actual weekly hours were 58.2. (*e*) Fifteen youths engaged in the light labor of boring top caps by means of automatic machines produced only 3 per cent. less output when their actual weekly hours of work were 54.5 hours than when they were 72.5 hours. (*f*) A part of the improvement in output was due to the workers starting work more promptly when on shorter hours. At one period the women engaged in turning fuse bodies lost on the average thirty-seven minutes daily by starting work after, and stopping before, the nominal time. Nine months later, when their hourly output was 25 per cent. better, they lost only twenty-six and one half minutes daily in these ways. (*g*) A rest from work on Sunday is followed by a relatively low output on Monday, and this output steadily rises in the course of the week, owing to the increased efficiency produced by practise. Generally, the cumulative effects of fatigue neutralize and overpower this increased efficiency, and the output may fall after the second day (or night) of the working week if the hours are long and the work laborious, or not till after the third, fourth or even fifth day, if the hours are shorter. In the absence of a Sunday rest, the fatigued worker has no opportunity for complete recuperation and his output, though more uniform, remains permanently at a lower level than that shown on Monday by a worker who has rested on Sunday.

ELECTRICAL ENGINEERS AS LIEUTENANTS IN THE U. S. NAVAL RESERVE

1. The Secretary of the Navy has authorized the commissioning of one hundred graduate electrical engineers as lieutenants, junior grade, in the Naval Reserve, and directed that the necessary action be taken to provide these officers at the earliest practicable date.

2. The qualifications for such officers to be in general as follows: (*a*) Citizens of the United States. (*b*) College graduates in electrical engineering. (*c*) Not less than three years' employment in electrical work since graduation. (*d*) Between twenty-five and thirty-five years of age. (*e*) Of character and physique required for officers of the regular service.

3. Pay and allowances of lieutenants, junior grade, are the same as in the regular Navy, and are, approximately: $2,200 at sea; on shore, including allowances for commutation of quarters, heat and light, $2,480. There is an

additional allowance of $150 for uniforms in time of war.

4. Eighty-five nominations of electrical engineers meeting the above requirements to be made by each of the following agencies:

(*a*) Naval Consulting Board.

(*b*) National Research Council.

(*c*) American Institute of Electrical Engineers.

5. Upon receipt of the 255 nominations thus made certain forms will be sent each nominee to execute, and upon receipt of the executed forms a Board of Naval Officers will select 100 for appointment.

6. After appointments have been made the officers so nominated and selected will be given a month's training and instructions on shore in naval methods, customs and regulations and instructions. Pay will begin on date of appointment.

7. Upon completion of the month's training on shore they will be ordered to the active fleet as electrical officers of ships for a period of at least six months. After this period they will be assigned to duty as the exigencies of the service may demand, excepting such as may be unfitted for the naval service.

8. The utmost care will be exercised in the nomination of these candidates as regards professional ability, physical condition, temperament and bearing, to the end that each one may qualify and not be subjected to inconvenience and disappointment and that the Navy may be benefited accordingly.

9. The Provost Marshal General of the U. S. Army has stated that any one subject to the Selective Draft Law may be released from compliance in order to accept an appointment as officer in the U. S. Naval Reserve Force.

10. Any one who now is in the Army, either volunteer or drafted, may make application but must obtain his discharge before he can be appointed. This includes any one who has been directed to appear before an exemption board. Those now in the Naval Reserve are eligible.

11. Individual nominations will be received, but any one making such should first assure himself that his nominee will agree to serve if selected and give as much information as possible to assist the committees in making nominations to the Department.

12. Any member of the electrical profession who can meet the technical requirements and who can submit proper credentials may make direct application to the undersigned.

13. To facilitate the work of selection, applicants should submit, in time to reach the committees not later than *October 15*, the following detailed information on the attached blank.

14. Letters from at least three responsible personal acquaintances should accompany each application.

15. From the nominations received the undersigned will each select 85 names to be forwarded to the Bureau of Navigation, Navy Department, Washington, D. C., from which total 100 names will be finally selected for commissions.

Applications may be sent to any one of the undersigned:

NAVAL CONSULTING BOARD OF THE U. S.,
13 Park Row, New York,
NATIONAL RESEARCH COUNCIL,
33 West 39th Street, New York,
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS,
33 West 39th Street, New York.

NEW YORK,
October 3, 1917

THE PSYCHOLOGICAL EXAMINATION OF RECRUITS

As was announced in SCIENCE at the time, a committee on psychology has been organized, with the approval of the council of the American Psychological Association, by the National Research Council. This committee consists of J. McKeen Cattell, G. Stanley Hall and E. L. Thorndike, from the National Academy of Sciences; Raymond Dodge, S. I. Franz and G. M. Whipple, from the American Psychological Association, and C. E. Seashore, J. B. Watson and R. M. Yerkes, from the American Association for the Advancement of Science. Dr. Yerkes, this year president of the American Psychological Association, lately professor of comparative psychology at

Harvard University and recently elected head of the department of psychology at the University of Minnesota, is chairman of the committee, and has been made a major in the Sanitary Corps of the Army in charge of the Section of Psychology, which has been established in the office of the Surgeon General.

A number of committees were organized and are now at work on different problems connected with the conduct of the war and national efficiency, partly under the auspices of the office of the Surgeon General and partly in the office of the Adjutant General. Information concerning the work of the committee on the psychological examination of recruits has been communicated to the press.

The members of that committee are R. M. Yerkes, W. V. Bingham, professor of psychology, Carnegie Institute of Technology, Pittsburgh; H. H. Goddard, director of research, the Training School, Vineland, N. J.; T. H. Haines, professor of medicine, Ohio State University; L. M. Terman, professor of educational psychology, Stanford University; F. L. Wells, psychopathologist, McLean Hospital, Waverley, Mass.; and G. M. Whipple, professor of educational psychology, University of Illinois. This committee met continuously for two weeks planning methods and tests. The seven men then separated, went to various parts of the country and applied the methods in actual practise. After making about 500 examinations they gathered again for two weeks and worked over the methods.

Six weeks after the first gathering of these psychologists, their test sheets, report blanks, etc., were ready for the printer. Arrangements were made for a trial of the method under working conditions with large numbers of men. About 4,000 men in regular organization camps, officers' training camps and naval stations, were examined, and special attention was given to correlating the ratings from the psychological examinations with the ratings prepared by the usual army methods.

The results of these thousands of examinations were sent to Columbia University, where, under the direction of Professor Thorndike and with the cooperation of Professor Cattell, Professor Woodworth and other members of the department of psychology, ten assistants and computers worked a month assembling and analyzing the statistical results. Again the seven psychologists went over their methods in the light of these 4,000 examinations to make further improvements.

The psychological examinations are now in progress in four of the national army cantonments: Camp Devens, at Ayer, Mass.; Camp Dix, at Wrightstown, N. J.; Camp Lee, at Petersburg, Va.; and Camp Taylor, at Louisville, Ky. There are about 160,000 men to be examined in these cantonments, and each will receive an intelligence rating as a result of the psychological examination.

The work is undertaken, first, to supplement the medical examination and second, to give line officers estimates of the mental ability and special aptitudes of their men. Reports of the psychological examinations will be made to the chief surgeon of the camp or the psychiatric officer in order that those mentally incompetent may be considered for discharge, and to the regimental and company officers in order that they may use this additional information concerning their men for the improvement of the service.

SCIENTIFIC NOTES AND NEWS

Dr. Otto Klotz has been appointed chief astronomer and director of the Dominion Astronomical Observatory at Ottawa.

Dr. Salvador Debenedetti has been appointed to the directorship of the Museo Etnografico at Buenos Aires, in place of the recently deceased Dr. Juan B. Ambrosetti.

Clarence Ebaugh, professor of chemistry in Denison University, is on leave of absence for the year 1917–18, to serve as chairman of the Council of National Defense for the state of Utah.

Dr. John Preston, superintendent of the State Insane Hospital, Austin, has been appointed by the Medico-Psychological Society to organize neuropsychiatric hospital units to be attached to the base hospitals and other

military sanitary units. Dr. Preston has appointed the following committee to carry out these plans: Drs. Marvin L. Graves, Galveston; John S. Turner, Dallas; George F. Powell, Terrell; Thomas B. Bass, Abilene; James R. Nichols, Austin, and John W. Bradfield, Austin.

DR. G. BACHMANN, professor of physiology in the Emory University School of Medicine, has been appointed cardio-vascular examiner with the rank of first lieutenant and has been assigned to duty at Camp Gordon, Atlanta, Ga.

MAJOR CHARLES F. HOOVER, professor of medicine, Western Reserve University and assistant director of Lakeside Base Hospital in France, is now in Cleveland on leave of absence.

DR. RESTON STEVENSON, assistant professor in charge of physical chemistry in the College of the City of New York, has been appointed captain of the Sanitary Corps of the United States Army.

SEVERAL members of the faculty of the Pennsylvania State College are on leave of absence for national work. Professor E. D. Walker, head of the department of civil engineering, is captain in Company A, of the 5th regiment of Engineers, which left Pittsburgh about July 8 for foreign service. Professor Hugo Diemer, head of the department of industrial engineering, has received a commission as major in the Ordnance Department. He is at present located at Lowell, Mass., in charge of the inspection of fire arms. Other members of the faculty who are in military service are Mr. J. J. Light, of the department of mechanical engineering, who has been commissioned a captain; Lieutenants Steel, Long and Bryans, of the department of civil engineering, are on duty at various camps; Mr. Mills, of the electrical engineering department, is in Washington on naval construction.

OF the members of the instructing staff of the department of chemistry at the Massachusetts Institute of Technology, Professors W. H. Walker and J. F. Norris, Dr. F. H. Smyth and Mr. R. E. Wilson are on leave of absence, and Professor W. K. Lewis devotes only part of his time to the institute during the present year. All these men are actively engaged on gas-defense problems, and are holding responsible positions in the organization which is dealing with these problems at Washington and elsewhere. Professor A. A. Noyes spends a part of his time at Washington, in connection with the work of the National Research Council and the Nitrate Committee. Professors Mulliken, Spear and Mueller have also been engaged at the institute on investigations relating to gas-defence. Professors F. J. Moore and H. P. Talbot gave, during a portion of the summer, courses of instruction to students who were expecting to apply for commissions in the Reserve Officers Training Corps.

AMONG the appointments recently made in the state department of education and registration by the governor of Illinois are those of Professor Thomas C. Chamberlin, head of the department of geology at the University of Chicago, and Professor John Merle Coulter, head of the department of botany at the same institution, to the Board of Natural Resources and Conservation. Professor Chamberlin is commissioner of the Illinois Geological Survey and has been president of the Illinois Academy of Sciences. Professor Coulter is now the president of the Chicago Academy of Sciences and has been for many years a special agent in botany for the United States Department of Agriculture. The Board of Natural Resources and Conservation is part of the state department of education and registration, at the head of which is Francis Wayland Shepardson, formerly associate professor of American history at the University of Chicago.

FRANK CARNEY, Ph.D., professor of geology and geography at Denison University, has resigned to enter the employ of The National Refining Company of Cleveland, Ohio.

PROFESSOR H. F. CLELLAND, secretary of the New England Intercollegiate Geological Excursion, announces that the excursion will be taken on Friday and Saturday, October 12 and 13, and will be in charge of Professor J. B. Woodworth, of Harvard University, and Dr. Edward

Wigglesworth, of the Boston Society of Natural History. It is planned to visit the cliffs of Weyquobsque, Nashaquitsa, and Gay Head, on the island of Martha's Vineyard. Information can be obtained from Professor Woodworth at the Geological Museum, Oxford St., Cambridge, Mass. Circulars will be sent to all persons on the secretary's list.

At Harvard University, a plan for an investigation of the stratigraphy of the Ordovician formations of the Appalachians has been approved by the committee on the Shaler Memorial Fund. Three seasons, under the supervision of Professor Percy E. Raymond, have been arranged. During the past summer, work has been carried on in Vermont, Pennsylvania and Virginia by Dr. Raymond, in collaboration with Mr. Richard M. Field, lecturer at Brown University, Professor E. W. Shuler, of Southern Methodist University, and Professor S. L. Powell, of Roanoke College.

The National Geographic Society's expedition to Mount Katmai, which sailed for the north on May 28, reached Seattle on September 30. The head of the expedition is Dr. Robert F. Griggs, of the Ohio State University.

The Elisha Mitchell Scientific Society held its business meeting September 20. The following officers were elected: Mr. J. G. Beard, president; Dr. J. M. Bell, vice-president; Mr. W. W. Rankin, recording secretary. The following board of editors was elected for the *Elisha Mitchell Journal:* Dr. W. C. Coker, chairman, Mr. M. H. Stacy and Mr. Collier Cobb. The following were elected to membership in the society: Dr. A. W. Hobbs, Messrs. B. Markham, H. M. Sharpe and W. W. Kirk; to associate membership in the society: Messrs. J. C. Bynum, L. G. Marsh, G. B. Lay, W. W. Eagle, E. H. Griffin, W. F. Morrison, R. W. Parks, J. W. Sawyer, N. A. Reasoner, J. W. Smithey, C. H. Herty, Jr., R. H. Rimmer, B. L. Meredith, I. V. Giles, and R. D. Ballew.

The California Academy of Sciences has provided a course of lectures on popular scientific subjects to be given at three o'clock each Sunday afternoon in the auditorium of the Academy's Museum in Golden Gate Park, as follows:

September 23. Professor S. J. Holmes, department of zoology, University of California, "Social evolution and eugenic progress."

September 30. Professor C. A. Kofoid, department of zoology, University of California, "A visit to Easter Island," illustrated by stereopticon.

October 7. Dr Barton W. Evermann, director, California Academy of Sciences, "Birds of Pyramid Lake," illustrated by moving pictures.

October 14. Dr. Chester Stock, department of paleontology, University of California, "Pleistocene caves of California."

October 21. Dr. H. W. Fairbanks, supervisor of geography, Berkeley Schools, "Influence of climate and topography upon California's development."

Dr. Charles Hughes Johnston, professor of education in the University of Illinois and editor of *Educational Administration and Supervision,* was killed in an automobile accident near Elkridge, Md., on September 3, aged forty years.

The department of zoology of Smith College has been presented by the Boston Society of Natural History, through its curator, Dr. W. C. Johnson, with a complete collection of the land and freshwater mollusks of Massachusetts. This collection—every specimen of which is accurately determined and labelled by Dr. Johnson, will serve as a standard of comparison for any one wishing to identify the local molluscan fauna.

The *Indian Forester,* as quoted in *Nature,* describes the organization of the Chinese Forest Service, which came into existence in January, 1916, as a subordinate branch of the Ministry of Agriculture and Commerce at Peking. The heads of the service, styled "co-directors," are Mr. Forsythe Sherfesee, for six years employed in, and lately director of, the Philippine Forestry Bureau, and Mr. Ngan Han, who studied forestry in Cornell and Michigan universities several years ago. There are other Chinese in the service, who have received a technical training in the United States, and an expert from Kew, Mr. W. Purdom acts as botanist and is chief of one of the six divisions into which the service is organized. In this article an ambitious program of afforestation, education, propaganda,

etc., is sketched out, but no details are given of any work that has been actually accomplished.

IN connection with the search for potash and nitrates in the United States the government receives many reports of supposedly valuable discoveries. A letter recently received by the United States Geological Survey of the Interior Department describes a cave in one of the Southern States which was worked by the Confederacy during the Civil War for potassium nitrate. This cave is said to contain at least 1,000,000 tons of nitrous earth, which, however, contains only 1 to 2 per cent. of nitrate. The survey now states that it seems very doubtful whether such material can be profitably used as a source of nitrate salts. The minimum grade of caliche now worked in the Chilean fields contains 12 per cent. of sodium nitrate, and though there has been much criticism of the crudeness of the methods employed there, the work is done by very cheap Indian labor, and it is doubtful whether leaner material could be worked to advantage here, where the price of labor is so much higher. Several hundred thousand dollars have recently been expended in one of the Western States in testing the proposition to utilize low-grade nitrate. The results have been negative. The nitrate caves in the South were worked during the Civil War by very crude methods. Generally the cave earth was shoveled into iron pots, where it was treated with water and heated over wood fires to leach out its soluble parts. The liquor was drawn from one pot into another and used for treating fresh material until it became a highly concentrated solution of nitrate salts. It was then drawn off and allowed to cool, whereupon the nitrate crystallized. The remaining liquor was then employed to leach fresh material and the crystals were separated and sacked for use.

To make the desert regions of the western part of the United States more accessible by locating their widely separated watering places and erecting hundreds of signposts to give directions and distances to the watering places is an interesting and practical project recently undertaken by the United States Geological Survey, Department of the Interior. The project involves also the work of making accurate maps showing the locations of the watering places, of preparing guides describing them and giving the distances between them, of selecting well sites, and of developing watering places (so far as money available will permit) in localities where water is most needed and where the geologic investigations indicate that underground supplies can be obtained. It is expected that this work will help to expedite the discovery and development of the rich mineral deposits in parts of these regions. It will, of course, also be valuable in other respects. In recent years the water-supply geologists of the Geological Survey have developed trustworthy methods of locating ground water in arid regions from surface indications and of estimating the depth to water and the approximate annual yield of the underground reservoirs. These methods will be applied and further developed in connection with the survey of desert watering places. A number of Survey parties are now being organized in Washington and will in a few weeks be at work in the most arid parts of Arizona, California, and Nevada. Each party will consist of a geologist and one or more assistants and will be provided with an automobile and camping outfit.

UNIVERSITY AND EDUCATIONAL NEWS

THE will of Miss Kate Collins Brown, formerly of New Orleans, who died on August 19, disposes of an estate of more than $700,000 of which she left nearly $500,000 in direct bequests and gave the residue to Columbia and New York Universities and the Presbyterian Hospital. The share of the educational institutions is to establish scholarships paying $300 a year to needy students.

THE Pacific Coast Gas Association has given $4,415 to the University of California to further instruction and research in gas engineering.

THE nineteenth annual conference of the Association of American Universities will hold

its annual meeting at the State University of Iowa on November 8, 9 and 10.

The Rev. Dr. Anson Phelps Stokes, secretary of Yale University, has been chosen principal of Hampton Normal Institute, to succeed the late Dr. V. B. Frissell.

Dr. William B. Meldrum, of Vassar College, has been appointed assistant professor of chemistry at Haverford College, taking the place of Lyman B. Hall, professor of chemistry, who resigned at the retiring age after thirty-seven years of service.

The following changes have been made during the summer in the staff of the department of geology at the University of Illinois: Professor C. W. Rolfe has retired as professor emeritus. Mr. Fred H. Kay, lecturer on petroleum geology, has gone into the service of the Sun Oil Company; Dr. F. M. Van Tuyl, instructor, has resigned to accept the assistant professorship of geology in the Colorado School of Mines; Dr. C. W. Tomlinson, A.M. (Wisconsin), Ph.D. (Chicago), has been appointed associate in structural and general geology.

Mr. F. A. C. Perrine has resigned as assistant professor of psychology at the University of Pittsburgh to accept the position of adjunct professor of psychology at the University of Texas. Mr. Jos. U. Yarbrough was made an instructor in psychology at the University of Texas.

Dr. J. W. Beede, associate professor of geology at the Indiana University, has accepted a position in the bureau of economic geology and technology, in the University of Texas.

At Cornell University, Bernard A. Chandler has been appointed assistant professor of forest utilization for 1917–18, in place of Professor A. B. Recknagel, who is absent on leave.

DISCUSSION AND CORRESPONDENCE

INTERNATIONAL UNITS AND SYMBOLS IN AEROGRAPHY

To the Editor of Science: In the somewhat appreciative review of the text-book on "Aerography" in Science, September 14, 1917, on p. 265 is the statement "the student may be confused in having absolute pressure units presented as 'kilobars' when they are commonly known as 'millibars.'" The reviewer underestimates the intelligence of university men; because the reasons why kilobar is preferable are given at length on page 30. Kilobar is as natural as kilogram. It may also be added that those who persist in advocating the retention of millibar are evidently not aware that V. Bjerknes expressly states that in his system the C.G.S. unit will be the *microbar*.

Again, the statement of the reviewer that "kilobar has historic preference over millibar but millibar is the internationally accepted term" is both inaccurate and misleading. Millibar is the earlier term and it has international acceptance only because there has been no opportunity to have the mistake corrected by international agreement. Moreover it is extremely problematical if the International Congress will ever meet again. But is it good form in scientific work to continue the use of an erroneous term because an official disclaimer is lacking? There are some other matters which are of perhaps greater moment. It is a strange commentary upon the work of the International Meteorological Congress that while giving us symbols for no less than 23 conditions varying from haze to aurora, there are no symbols for bright and diffused sunshine, mountain and valley winds, temperature inversion and sea-breeze. For the last named, the sea-breeze, we have been using at Blue Hill, three arrows on a vertical staff, to represent the characteristic changes in circulation. As the sea-breeze is a frequent and very important aerographic condition, any suggestion for a more fitting symbol will be appreciated.

Alexander McAdie

Blue Hill Observatory,
Readville, Mass.

SYMBOLS

I am confident that there is not a worker in the wide domain of physical science who

has not wished for a standard series of symbols. The question is not a new one; it was considered by a committee of the American Association for the Advancement of Science many years ago, but its efforts were shattered in the attempt at international cooperation. Such cooperation is very desirable, but if it is not available that is no reason why America should deny herself the benefits of coordination which she, with her scientific resources, may devise. Every monograph, every textbook that is written adds to the confusion of symbols, for there are no standard tables to guide one. It seems to me not only possible, but practicable that a list of symbols could be compiled under various headings—mathematical, astronomical (with subdivisions), physical (with subdivisions), geophysical, electrical, etc. The various headings would be necessary because the same symbol is frequently used under different headings, and, of course, with different meaning. Whether we write g for terrestrial acceleration or a is fundamentally quite immaterial, so it is whether we write L, or ϕ, or λ for latitude, but it is not immaterial for the person who reads it. He will probably wonder why the writer doesn't use such and such symbol. We want uniformity, uniformity to as great an extent as possible. Personal preferences should be waived and sunk in the greater scheme of uniformity. There are already many constants, many expressions, many concepts that await being labeled for common recognition. Who is to undertake this work, who is to do the labeling? I can see, or rather I can hear rumbling—"I'm not going to be bound by any such tables." Quite so, they would have no authority whatever. However the dictates of common sense would be their propelling force and I think the vast majority of American scientific writers would avail themselves of their usefulness. Anything that promotes readiness of understanding and ease of reading mathematical expressions and equations should be encouraged.

In order to give definiteness to my ideas, which I hope will arouse discussion, I would suggest that the tables of symbols spoken of be prepared by the Carnegie Institution of Washington. It is work that so eminently falls within its scope, and it is so well equipped with material and other resources, that one can look forward with confidence to a well-matured publication. Should the work be undertaken by the Carnegie Institution nothing would further the general adoption of the symbols promulgated more than the wide distribution of the publication and that could be profitably effected by sending to every scientist—to every man in "American Men of Science"—gratis a copy of the Carnegie publication.

My closing word: Don't let details smother uniformity. Make a start.

OTTO KLOTZ
DOMINION OBSERVATORY,
OTTAWA,
August 4, 1917

BACTERIAL LEAF SPOT OF TOBACCO

A BACTERIAL leaf spot of tobacco has been found to occur within certain sections of North Carolina. This disease, because of the rapidity with which it spreads, has appropriately been given the name "wild fire." It first manifests itself in seriously destructive form at the time of transplanting, so that in some fields it has been necessary to replace the seedlings by a second and a third transplanting. Plants in the seed beds from which these seedlings were taken have been found to be diseased, indicating that the malady was introduced from the seed beds.

The disease first appears as circular yellow spots about 1 cm. in diameter. A minute brown area indicates the center of the spot. Within a few days the brown area will have enlarged to 2 or 3 cm. in diameter with a translucent border and surrounded by a wide chlorotic halo. When the spots are numerous they fuse, forming large brown irregular areas which in severe cases involve most of the leaf tissues.

Isolation and inoculation work has shown that the disease is due to a grayish white bacterial organism which is heretofore undescribed. This organism is rod shaped, about three times as long as wide, and actively motile

by a single polar flagellum. It is therefore referable to Cohn's Bacterium as amended by Smith and is given the name *Bacterium tabacum*. The detailed account of the cultural studies and inoculation experiments which have been made, and of the distribution and dissemination studies which are in progress, is reserved for subsequent publication.

F. A. Wolf,
A. C. Foster
North Carolina Experiment Station

PLANT DISEASES IN CANADA

To the Editor of Science: Two plant diseases have recently been observed in the Dominion of Canada which have not been recorded before, viz., *Dothichiza Populea* Sacc. et Briard, on Lombardy poplar, St. Andrews, N. B., and *Colletotrichum cereale* Manns, on spring wheat, Charlottetown, P. E. I.

A third disease affecting seed pods of turnips grown for seed in P. E. I. caused by *Leptosphaeria Napi* (Fuckel.) Sacc., of which the conidial form *Sporidesmium exitiosum* was found, does not appear to have been recorded as causing trouble on the continent of America. It is well known in Europe, where it is disastrous to seed turnip cultures.

H. T. Güssow

COMMON PLANT NAMES

To the Editor of Science: May I draw attention to a point in the discussion on popular names of plants, which M. A. Bigelow, in Science of July 6, seems to ignore; that is, the great literary value of a good common name and the danger that such names may be lost through being ignored by teachers. Of course children can learn any name—they memorize far more easily than grown people—but do not let us give them scientific names to learn as a part of nature study, unless they are going in for botany as a science. Scientific names are usually clumsy and pedantic, almost always lacking in character, and often can not be gracefully absorbed into the English language.

The names which Professor Bigelow cites as being both popular and scientific are sufficiently euphonious, but are almost all those of garden plants, which may be allowed to bear florists' names. The few wild flowers he mentions all have good common names, which apparently he is willing to discard. Primrose is an older name than *Primula*, I fancy, and for the matter of that, surely rose, lily and violet antedate the systematists! *Clematis* and *Trillium* are pretty enough, but virgin's bower and wake-robin are names to make a poet sing for joy. Most eastern wild flowers have fairly good names and even in the west—a young civilization is apt to be content with variations of "bells" and "roses"—they have some fine names, such as "our Lord's candle" (*Yucca Whipplei*), "sweet-after-death" (*Achlys triphylla*) and "flaming sword" (*Fouquiera splendens*). Such names as these enrich our language and should be preserved at all costs.

Shall we encourage children to gather nosegays of *Blepharipappus, Mesembryanthemum* and *Malacothrix*? Heaven forbid! Only give them time and children will evolve good names for all conspicuous wild flowers, if we do not thwart them by teaching the scientific ones unnecessarily. Cat's breeches, named by Utah children, may not be elegant, but it is quaintly appropriate and is certainly better for everyday use than *Hydrophyllum capitatum*. Let us go slowly in these matters and so long as men like Dr. Jepson are continually on the lookout for good common names we need not despair.

Margaret Armstrong

A SIMPLE EXPLANATION

In Science, August 31, 1917, page 212, Professor C. A. Mooers writes as follows:

> The writer has assumed that Dr. Hopkins could give a simple explanation for his conflicting estimates, as given in Science, November 3, 1916, p. 652, and in Science, March 2, 1917, p. 214. In the former article he says: "For each dollar invested rock phosphate paid back $2.29," but in the latter article he says, with regard to the same data, "Easy computations show profits per dollar invested of . . . $1.29 from phosphate rock."

The "simple explanation" is that these are not conflicting statements. Each dollar invested in raw rock phosphate paid back $2.29; and, when the dollar invested is subtracted from this amount, the profit is found to be $1.29.

In this article Professor Mooers bases his opinions in part upon "observations" and "hay data . . . not given in Bulletin 90," states that in his conclusions he "was governed chiefly by a consideration of the soil conditions and the results of the individual series"; and he criticizes my use of a summary table which he prepared and which he also used in his bulletin[1] and in his former SCIENCE article.[2] His present opinion is that this summary table is not fairly representative of the results secured, and I must bear his criticism for having used it.

CYRIL G. HOPKINS
UNIVERSITY OF ILLINOIS

QUOTATIONS

COLUMBIA UNIVERSITY AND PROFESSOR CATTELL

IT is contrary to the academic traditions of six hundred years to dismiss a university professor on account of his opinions expressed in a proper way to experts in the subject. It is illegal to dismiss a professor in the middle of the academic year on false and libelous charges, without payment for the year and without the pension which he had earned by twenty-six years of service.

I am opposed to war and to this war, but I have undertaken no agitation against the government nor against its conduct of the war. I have written nothing against the draft law or against sending armies to Europe, although I regard both measures as subversive of the national welfare.

It is because I care for my country that I deplore its entry into a war of aggression and the government's policy of strangling democratic principles at home. For the same reason I have in the journals which I edit done what I could to promote national efficiency. I am a member of the Psychology Committee of the National Research Council and spent a large part of last week drawing up for the War Department plans for the scientific selection of aviators.

In August, 1914, when President Wilson was telling us to be neutral in thought as well as in speech and in act, and Mr. Roosevelt and Dr. Nicholas Murray Butler were "pussy-footing," I wrote in one of the journals that I edit:

> The official German justification of the mad and wanton European war is that it is in defense of the Teutonic culture and people against the semi-Asiatic and barbaric Slav hordes. The verdict of history will probably be that it was a war of calculation for caste and national aggrandizement, and a war of miscalculation. The German emperor and his bureaucratic military entourage probably held that the time was ripe for an extension of German influence in the Balkans and towards Asia Minor with an increase of its African possessions at the expense of France. But it is not clear why, if the serpent was prepared to use its fangs, it did not show its alleged wisdom. . . . We may look for a second Napoleon the little rather than for a second Napoleon the great.

In June, 1917, I began a letter to the New York *Evening Post* with the words:

> An emperor, driven by the militaristic and capitalistic classes of his people and "by God demented," must accept responsibility for the great crime.

The letter that I wrote on August 23 to members of the Congress, on account of which I have been dismissed from the chair of psychology at Columbia University, asked support for a measure then before the Senate and the House to prohibit sending conscripts "to fight in Europe against their will." There is no law requiring or permitting the President to send "conscientious objectors" to fight in Europe. To do this would be contrary to the intent of the constitution and to the uniform policy of the nation. It would provide a less efficient army and might cause disorder and possible revolution at home. Surely this should not be done without careful consideration by the Congress after efforts to learn the

[1] Bulletin No. 90, Tennessee Agricultural Experiment Station.

[2] SCIENCE, January 5, 1917.

will of the people. I have only exercised the constitutional right and fulfilled the duty of a citizen in petitioning the government to enact legislation which I believe to be in the interest of the nation. For this I am dismissed from the division of philosophy, psychology and anthropology, which I have made the strongest in the world. Professors in every university are terrorized, so that they dare not exert their influence for peace and good will.

The people of all the European nations long for peace, but are kept at war by the kleptocratic classes. In spite of the institutions and the instincts which we have inherited from a barbarous past, I believe that our people have no heart for this war into which they have been driven. But even if the nation should become a mob mad for war, it is none the less the business of each of us to do what he can for righteousness as he sees it. If that is forbid by force, then indeed we need a new national anthem, such as Shelley once wrote for England:

> God prosper, speed and save,
> God raise from England's grave
> Her murdered Queen!
> Pave with swift victory
> The steps of Liberty,
> Whom Britons own to be
> Immortal Queen.

—J. McKeen Cattell *in a statement printed in the daily press.*

SCIENTIFIC BOOKS

Chemistry in the Service of Man. By Alexander Findlay, M.A., D.Sc., F.I.C. Longmans, Green & Co., London, New York. 1916. Pp. xiv + 255. Price $1.60.

This book is the outgrowth of a series of lectures—the Thomson Lectures—delivered by the author before the United Free Church College at Aberdeen, near the close of the year 1915. It represents the attempt to lay before a group of college men, who made no claim to chemical knowledge, some account of what chemistry has accomplished for the well-being and uplift of mankind, and also some glimpse of the relation of chemistry to the war. The book is in England especially timely, from the fact that among the educated classes, as well as among the business men and industrialists, an appreciation of chemistry has been sadly wanting. The case is somewhat different in this country, since for many years chemistry in a large share of our colleges and universities has been either a required study or a widely chosen elective, and has become a part of the curriculum of most of our high schools. Probably on account of this our manufacturers have shown far less reluctance than those of England to abandon their "rule of thumb" methods.

Such books as the one before us are always timely, never more so than to-day, provided the author is a master of his subject and at the same time capable of expressing his thought in language that can be understood by the man with little or no previous knowledge of chemistry. Dr. Findlay well fulfils both of these conditions. His work in physical chemistry is well known; his success in opening up difficult fields in chemistry to the comprehension of the ordinary chemist is evidenced by the clearness of his "Phase rule and its applications" and his "Physical chemistry and its applications in medical and biological science." This latter book, by the way, should be read by every medical student.

The aim of "Chemistry in the service of man" is best set forth in a sentence in the introductory lecture: "In attempting a brief and necessarily incomplete survey of chemistry in the service of man, I shall endeavor not merely to recount some of the manifold ways in which chemistry has revolutionized life and has contributed, on the material side, to a civilized existence; but I shall try, also, to indicate, if I can not do more, some of the principles which underlie chemical change, and some part of the contribution which chemistry has made to our knowledge of the constitution of matter." The latter is rather an ambitious program for a *popular* book, intended for readers without previous knowledge of chemistry. The chapters entitled "Velocity of reaction and catalysis," "Electricity and chemistry," "The colloidal state," and "Molecular structure" would

hardly seem fitted for *popular* perusal, and yet so clearly are the fundamental principles treated that any intelligent man, or high-school scholar, for that matter, would hardly fail to be understandingly interested in the application of these principles to important facts of every-day life. The consideration of catalysis leads to its application in the manufacture of sulfuric acid and the hardening of fats, and to some of the facts concerned with digestion; in connection with electricity are discussed the refining of metals, the manufacture of chlorin and caustic soda, and many electric-furnace products; the colloidal state is illustrated by photographic plates, the sedimentation of rivers, plasticity of clay, dyeing and water and sewage purification. Perhaps the most interesting chapter is that concerned with the fixation of nitrogen, particularly applicable to the demand, both for munitions and for fertilizers, at the present time. Other chapters are "Combustion, and the production of fire," "The chemistry of illuminants," "Energy, fuel and explosives," "Cellulose and cellulose products," "Glass, soda, soap," and "Synthetic chemistry." All are exceedingly readable, and are to be recommended, not only to the man who desires to get a glimpse of what modern chemistry is doing for the comfort and needs of life, but quite as well to the first-year student of chemistry, in school or in college, who has far too often come to regard the study as a mass of unconnected facts and abstruse theories, mingled with a mess of dirty test tubes and beakers. In this book one gains a glimpse of the beauty of it all, if indeed one has any comprehension of beauty.

One word remains to be said. Many of us were trained in our earlier years to believe that for the past half century all chemistry was "made in Germany," and in this there was far more of truth than of fiction. And yet it is hardly an exaggeration to say that in England, America and France more progress has been made in the past thirty-six months than had been made in Germany in the previous thirty-six years. Perhaps the same has been true of Germany; our information regarding this is meager. As never before, chemistry is "coming to her own," and hence the timeliness of Dr. Findlay's "Chemistry in the service of man."

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Ulugh Beg's Catalogue of Stars. By EDWARD BALL KNOBEL. Carnegie Institution of Washington, Publication No. 250. 1917. Pp. 109.

Mr. Knobel's compilation of Ulugh Beg's Catalogue forms a fitting sequel to Ptolemy's Catalogue of Stars, also edited by Mr. Knobel in conjunction with Dr. C. H. F. Peters. Ulugh Beg, born in 1394, succeeded his father as ruler of Persia in 1447. Two years later he was killed by his son. He devoted much of his time to astronomy, was the founder of an observatory at Samarkand, which is located in the southern part of Russian Turkestan, and in the year 1437 published a catalogue of stars.

Such catalogues furnish at best only rough determinations of stellar positions because of a number of causes. To add to the insecurity of the positions, it is not always certain whether all the stars of such a catalogue have been directly observed by the author, or whether, for the sake of completeness he has added star positions determined by predecessors, and reduced to the epoch of his own catalogue in a manner unrecorded. Added to this is the doubt whether the manuscripts available contain a true record of the original catalogue.

While it is eminently worth while to preserve such a catalogue, if only for historical purposes, great care should be taken not to place too great dependence upon its star positions.

Mr. Knobel has apparently made a thorough investigation of the subject. In addition to the catalogue proper he has included a comparison of Ulugh Beg's star positions with positions reduced from Piazzi's catalogue, with the exception of 300 stars whose positions were reduced from the catalogues of Danckwortt and Neugebauer. Following the comparisons he has collated the manuscripts which were examined, and closes the volume with a vocabulary of Persian words prepared

by Dr. Peters which Mr. Knobel has subsequently revised and amended.

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FIVE YEARS OF STARVATION OF LARVÆ

The specimens concerned are the larvæ of *Trogoderma tarsale,* a small beetle well known as a museum pest. The last of a large number of specimens lived, without a particle to eat, for the suprisingly long period of five years, one month and twenty-nine days or, to be more specific, from October 28, 1911, to December 25, 1916, a period of 1,884 days. The case is decidedly outstanding, as to my knowledge, nothing similar has ever been recorded as a result of starvation experiments with other animals. It is very probable that under otherwise non-disturbing conditions the starving larvæ would have lived for even a longer period. The specimens concerned in this article had undergone considerable disturbance after the first two years of starvation, since many of the larvæ made the trip between Idaho and Wisconsin with me three or four times, and several of them covered the distance five times. The trips one way varied in duration from four to seven days. There is no doubt but that the jarring of the train had accelerated the metabolism of the larvæ. This fact was evinced by the moulting of practically every individual toward the end of the trip or within a few days after it, and by the decided decrease in the dimensions of the larvæ immediately following such a moult. Larvæ placed under starvation shortly after my arrival in Idaho in the summer of 1913, which have not been so disturbed, show indications of even greater tenacity than is here recorded.

It will not be out of place here to mention how the starvation experiments with this particular species which proved to be of such unusual interest came about. While a graduate student at the University of Wisconsin the writer got into a dispute concerning the classification of the larvæ. To prove his point he decided to grow some of the specimens to maturity and thus obliterate the uncertainty of identification. A number of the largest larvæ available were placed in glass dishes together with some food material. Not having plenty of the favorite food material at hand at the time, several specimens were placed in other dishes without food and set aside in a separate drawer with the intention of providing for them later. However, these were neglected until the opening of school the following September when the writer accidently discovered them in their secluded place. Much to his surprise all of the specimens were alive, in spite of the fact that they had remained there for five months without a thing to eat. It was also noticed that the larvæ had decreased in size. This observation was further substantiated by the gradual decrease in size of the various cast-off skins, which this species is not known to attack. This interesting information later led to experimental work on the longevity of the larvæ, without food, on a large scale.

A number of specimens varying in size from newly hatched to practically full-grown larvæ were placed in individual sterilized vials for the purpose of ascertaining the period of time that they could live without food. Even the newly hatched specimens showed an amazing tenacity by living over four months without ever having eaten at all. Some of the one fourth grown specimens lived for fourteen months; those about one half grown lived almost three years; those three fourths grown lived four years; and most of the largest specimens lived over four years, several of them over four and a half years, and one five years and seven days; while the last one died after five years, one month and twenty-nine days of starvation.

One of the most interesting phases of these experiments is the gradual decrease in size of the individual specimens. Many of the largest larvæ which were about 8 mm. in length dwindled down to practically the hatching length of 1 mm. before dying, and practically all of the specimens which were below 7 mm. at the beginning of the experiment dwindled down to the same dimensions. Many of the larvæ of 2 and 3 mm. were reduced to some-

what below the hatching length, and practically all of the newly hatched specimens fell down to about three fourths of their original length. Speaking in terms of reduction in size, it is astonishing to note that some of the largest larvæ have been reduced to about 1/600 of their maximum larval mass.

Another, and even more interesting phenomenon, is the fact that when the starved specimens almost reach the smallest size possible and are then given plenty of food, they will again begin growing in size. A number of the larvæ which were half grown when placed under starvation for the first time, have through alternating periods of "feasting and fasting" attained that size three times and are now on the way to their fourth "childhood"; and even some of the large specimens have started dwindling down to their third "childhood" after having twice attained the practically maximum larval size.

Occasionally these larvæ are found in large numbers in insect, seed and drug collections, and naturally destroyed as soon as discovered. The writer would appreciate any amount of this living material that the reader may happen to find if he has no use for it himself. The larvæ, pupæ or living adults of other dermestids are equally desirable for the purpose of comparative studies. In response to a recent circular letter many men have already sent me some valuable material. The names of the donators will appear in the forthcoming detailed publication of this extensive and of necessity prolonged investigation.

The problem has now attained enormous proportions and involves the use of thousands of specimens. Many normal larvæ of different sizes, as well as many specimens in the different periods of starvation have been sectioned during the past few years, and comparative cytological studies of the various structures of the organisms are being made. Physiological studies with special reference to metabolic water and excretion have also been started.

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SPECIAL ARTICLES

THE RÔLE OF THE NUCLEUS IN OXIDATION[1]

IN 1897 Spitzer[2] reported that nucleoproteins extracted from certain animal tissues have the same oxidizing power as the tissues themselves. The idea that the nucleus is a center of oxidation was advocated by Loeb,[3] who pointed out that this would explain why cells deprived of nuclei live but a short time and are unable to regenerate missing parts. R. Lillie[4] sought to obtain direct experimental evidence by applying reagents which become colored on oxidation. He found the greatest amount of color in the neighborhood of the nucleus, indicating that it is a center of oxidation. Subsequent workers,[5] using stains which change color on oxidation, failed to agree as to the results.

Mathews[6] has stated that the nucleus is directly concerned in oxidation.

Warburg[7] found that NaOH increased oxidation in the sea urchin egg, but did not penetrate sufficiently to cause a change of color in the interior of eggs stained with neutral red. This is regarded by some as indicating that oxidation is largely confined to the surface of the cell.[8] R. Lillie[9] has recently found that the formation of indophenol in leuco-

[1] Preliminary communication.

[2] *Pflüger's Archiv*, 67: 615, 1897.

[3] *Archiv für Entwickelungsmechanik der Organismen*, 8: 689, 1899.

[4] *Am. Jour. Physiol.*, 7: 412, 1902.

[5] *Cf.* Wherry, E. T., SCIENCE, N. S., 37: 908, 1913; Schultze, W. H., *Verh. deutsch path. Ges.*, 16: 161, 1913; Reed, G. B., *Jour. Biol. Chemistry*, 22: 99, 1915. Unna, P. G. und Godoletz, L., Oppenheimer's *Handb. d. Biochem. Erganzungsband, S.* 327, 1913.

[6] Mathews, A. P., "Physiological Chemistry," 1915, p. 180.

[7] Warburg, O., *Zeit. f. physiol. Chemie*, 66: 305, 1910; *Biochem. Zeit.*, 29: 414, 1910.

[8] This conclusion does not seem to be necessary. *Cf.* Loeb and Wasteneys, *Jour. of Biochemistry*, 14: 459, 1913; also Osterhout; *Ibid.*, 19: 335, 1914. Owing to the buffer action of the protoplasm and to the presence of pigment the penetration of a small amount of alkali is not easily detected.

[9] *Jour. of Biol. Chemistry*, 15: 237, 1913.

cytes indicates that there is rapid oxidation at the surface of the cell as well as at the surface of the nucleus.

The objection might be made to the use of indophenol reaction that the result may depend somewhat on the manner in which the reagent penetrates. If the oxidizing substances of the cell are largely concentrated in the nucleus, those which are diffused throughout the cytoplasm will first meet the reagent at the cell surface and produce at that point a deposit of granules of indophenol. In the same manner the oxidizing substances which are retained within the nucleus will first meet the reagent at the surface of the nucleus and produce a deposit in that region. It would therefore appear that the reaction might be depended on if it showed the nucleus to have the greatest oxidative activity, since its error would lie in the opposite direction. But any conclusions drawn from it regarding oxidation at the surface of the cytoplasm would be of doubtful value.

It would seem that more reliable evidence can be obtained by investigating cases where it is not necessary that the reagent should penetrate from without owing to the fact that the cell itself produces the reagent.

The writer has studied a case of this kind in the Indian Pipe (*Monotropa uniflora*), which is extremely well suited to such investigations, because the cells contain a colorless chromogen which oxidizes and darkens very rapidly upon injury. An additional advantage is that the leaves are so thin and transparent that they may be placed under a microscope and the details of the cell structure studied with care before the cells are injured or treated with reagents.

In a typical leaf cell the cytoplasm is transparent and nearly colorless, with a few granules, while the nucleus is only slightly less transparent, is finely granular and has a nucleolus. When a leaf is mounted in a drop of water under a cover glass the cells remain for hours unchanged in appearance.

If an intact portion of the leaf is cut or crushed the cells in the neighborhood soon change. In the course of five or ten minutes the nuclei of the cells nearest the injury assume a more coarsely granular (or vacuolated) appearance and soon begin to darken. The darkening does not begin at the surface, but appears to take place almost simultaneously throughout the whole mass of the nucleus. Not until the nucleus has become very dark (so as to stand out very conspicuously when the preparation is viewed under the low power of the microscope) does the cytoplasm begin to darken perceptibly. It may be several hours after the nucleus has darkened perceptibly before a change of color can be perceived in the cytoplasm. The darkening of the cytoplasm does not seem to be more rapid at the surface than elsewhere.

That the darkening is due to oxidation is shown by the fact that it is retarded by the partial exclusion of air[10] and is inhibited by the usual means employed to prevent the action of oxidases. When young leaves (free from discolorations) are torn[11] and placed in water the torn edges become dark. This does not occur in 0.1 *M* HCl, 0.1 *M* KCN,[12] 0.1 *M* NaOH, or in boiling water. If the colorless chromogen is extracted by 0.1 *M* NaOH and kept in a tightly stoppered bottle so as to exclude oxygen it remains pale yellow for months, but if oxygen be admitted it soon turns deep red.

That the darkening of the nucleus is due to oxidation taking place in the nucleus itself and not to the taking up by the nucleus of a stain produced in the cytoplasm or vacuoles is shown by the following experiment: Plants were ground in a mortar and allowed to stand until they became black. The juice was squeezed out and centrifuged, giving an inky fluid. In this were placed pieces of leaves

[10] That the oxidation is not completely inhibited by exclusion of air is doubtless due to the fact that a considerable supply of combined oxygen is present in the cell which can be used for oxidation of the chromogen.

[11] Cutting with a knife was avoided on account of the action of the metal.

[12] In 0.1 *M* NaOH and 0.1 *M* KCN the whole leaf becomes pale yellow and then colorless. The yellow color is doubtless due to the fact that the KCN solution is alkaline.

which had been treated with 0.1 KCN and then with water. The solution was allowed to stand until it became concentrated by evaporation: it then appeared black. It was found that where the nuclei had been squeezed out of the cut cells by the knife they had taken up some stain but not more than the cytoplasm. In cells which were merely cut open there was little or no staining.

We must therefore conclude that oxidation occurs more rapidly in the nucleus than elsewhere in the cell. The only way to escape this conclusion would be by assuming that at the moment of injury there is a sudden migration into the nucleus of some or all of the substances necessary for the oxidation. This is not only very improbable from a theoretical standpoint, but observation shows that it can not be the case, for in this migration the substances would mingle and produce the pigment either outside the nucleus, or at its surface, before any pigment appeared in the interior of the nucleus. Observation of the nucleus shows that the pigment appears as soon within the nucleus as at its surface.

We may therefore conclude that the substances necessary for oxidation do not suddenly migrate into the nucleus at the moment of injury but that they must exist there before the cell is injured.

We may ask why the nucleus does not become darkened in the normal condition of the cell. The investigation of several workers have made it probable that the pigments produced by oxidation under normal conditions are at once reduced, giving up their oxygen to other substances in the cell. When injury occurs the reduction is checked more than the oxidation, with the result that the pigment accumulates.

It is also probable that in many cases the injury brings the cells into contact with more oxygen than under normal conditions.

In order to compare these results with those produced by the indophenol reagent, leaves were placed in a mixture of equal parts of alpha naphthol (saturated aqueous solution) and para phenylene diamine (1 per cent. aqueous solution). If the reagents are freshly made up there is little action, but if they have stood long enough to take up oxygen or if H_2O_2 is added a purple color develops in the cells, which eventually becomes deeper in the nucleus. The result depends greatly on the condition of the reagent and the rate at which it penetrates the tissue.

The general conclusion is that while the indophenol reaction indicates that the nucleus is the center of oxidation it does not give as definite information on this point as does the formation of natural pigments within the cell resulting from the oxidation of substances normally present.

SUMMARY

Injury produces in the leaf-cells of the Indian Pipe (*Monotropa uniflora*) a darkening which is due to oxidation. The oxidation is much more rapid in the nucleus than in the cytoplasm and the facts indicate that this is also the case with the oxidation of the uninjured cell.

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SOCIETIES AND ACADEMIES

AMERICAN MATHEMATICAL SOCIETY

AT the invitation of Adelbert College and the Case School of Applied Science, Cleveland, Ohio, the twenty-fourth summer meeting of the American Mathematical Society was held at these institutions on Tuesday, Wednesday and Thursday, September 4–6, 1917. This was the society's second visit to Cleveland, the annual meeting having been held there in the winter of 1912–1913. On the present occasion the interest was reinforced by the meeting of the Mathematical Association of America, immediately following on September 6–7. The arrangements, which were in charge of a committee representing both organizations, included a joint session on Thursday morning, at which Professor L. P. Eisenhart presented an address on "Darboux's contribution to geometry," and a joint dinner on Wednesday evening, attended by seventy-six members and friends, to whom President Thwing, of Western Reserve University, spoke a word of welcome, which was followed by a number of informal responses to the calls of the toastmaster, Professor E. V. Huntington. The program on Wednesday afternoon included an inspection of the harmonic analysis apparatus of

Professor Miller, of the Case School, and an organ recital in the chapel. On Thursday afternoon President Thwing gave a garden party in honor of the visiting societies. Luncheon was served on each day at the Case Club, whose building was thrown open to the members afternoons and evenings. At the close of the meeting a vote of thanks was tendered to the authorities of the two colleges for their generous hospitality.

The meeting included the usual morning and afternoon sessions on Tuesday and Wednesday and the joint session on Thursday morning. Sixty-two members were in attendance. At the opening session Professor T. M. Focke, of the Case School, occupied the chair, which was filled in succession by Professors Hedrick, Cajori, G. A. Miller and Eisenhart. Professor Hedrick presided at the joint session. The council announced the election of the following persons to membership in the society: Dr. W. L. Crum, Yale University; Professor T. J. Fitzpatrick, University of Nebraska; Mr. T. R. Hollcroft, Columbia University; E. L. Ince, M.A., Trinity College, Cambridge, England; Mr. L. S. Odell, Manual Training High School, Brooklyn, N. Y.; Dr. T. A. Pierce, Harvard University. Five applications for membership in the society were received.

The following papers were read at this meeting:

Arnold Emch: "On the invariant net of cubics in the Steinerian transformation."

J. E. Rowe: "Theorems related to a point projection of the rational plane cubic curve."

J. E. Rowe: "Closed hexagons related to the rational plane cubic curve."

J. E. Rowe: "The projections of certain points upon the rational plane quartic curve."

Tomlinson Fort: "Some theorems of comparison and oscillation."

O. D. Kellogg: "Oscillation and interpolation properties of solutions of integral equations."

A. B. Coble: "Finite groups determined by $2p + 2$ points in S_p."

M. G. Gaba: "Complete existential theory of the postulates of the linear order η."

L. L. Dines: "The bordered Fredholm determinant and the related group of functional transformations."

R. G. D. Richardson: "Contributions to the study of oscillation properties of ordinary linear differential equations of the second order."

C. N. Moore: "On the summability of the developments in Bessel's functions."

G. A. Miller: "Groups formed by special matrices."

Virgil Snyder and F. R. Sharpe: "On the space involution of order 8 defined by a web of quadric surfaces."

R. W. Burgess: "A second approximation for cantilevers."

Florian Cajori: "L. Wantzel."

G. M. Green: "Conjugate nets with equal point invariants."

G. M. Green: "Plane nets with equal invariants."

Florian Cajori: "Newton's solution of numerical equations by the use of slide rules."

L. P. Eisenhart: "Transformations of planar nets with equal invariants."

L. C. Mathewson: "On the group of isomorphisms of a certain extension of an abelian group.

E. D. Roe, Jr.: "Some restricted developments."

E. D. Roe, Jr.: "A geometric representation. Second paper."

E. D. Roe, Jr.: "Integral functions as products."

Mrs. E. D. Roe, Jr.: "Interfunctional expressibility problems of symmetric functions."

E. L. Dodd: "The approximation or graduation of a mortality table by means of a sum of exponential functions."

D. C. Gillespie: "Repeated integrals."

W. A. Hurwitz: "An expansion theorem for systems of linear differential equations."

W. C. Graustein: "Note on isogeneous complex functions of curves."

Mary F. Curtis: "A proof of the existence of the functions of the elliptic cylinder."

John Eiesland: "A Plücker geometry of flats in odd n-space."

H. J. Ettlinger: "Theorems of oscillation for a generalized Sturmian boundary problem."

H. J. Ettlinger: "Theorems of oscillation for the general real, self-adjoint system of the second order."

E. V. Huntington: "Bibliographical note on the use of the word mass in current text-books."

L. P. Eisenhart: "Darboux's contribution to geometry."

Abstracts of the papers are published in the *Bulletin* of the society.

The next regular meeting of the society will be held at Columbia University on October 27. The San Francisco Section will meet on the same day at the University of California. The annual meeting of the Southwestern Section will be held at the University of Oklahoma, Norman, Okla., on December 1.

F. N. Cole,
Secretary